Airborne Power Supply Unit (APSU)

Completed Technology Project (2016 - 2017)

Project Introduction

The Airborne Power Supply Unit (APSU) is a programmable DC/DC converter that can supply multiple constant voltage or constant current outputs in a small enclosure, enabling power conditioning from a single battery bus to multiple experiments with differing requirements. The technology behind the APSU allows Suborbital Platforms and Range Services (SPARS) users requiring DC power distribution to minimize the number of battery packs and relays required for missions, thus reducing mass, volume, complexity, cost, and increasing flight safety and reliability. The primary beneficiary for this technology is the science customer as the APSU consolidates power distribution and generation to a single unit, alleviating the customer of this burden and allowing the Principal Investigator (PI) to focus on the science.

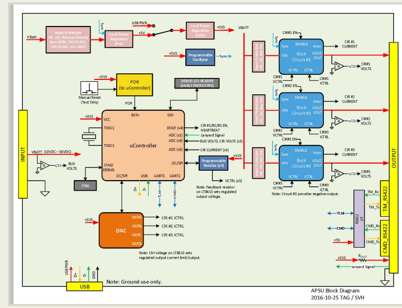
The APSU concept is based on a buck regulator circuit first developed for use on the AETD Diminutive Assembly for Nanosatellite deployables (DANY) experiment which required 3.3V constant voltage from a +28V battery source. Furthermore, the buck regulator circuit was also flown and provided the flexibility late during integration to regulate the +28V battery bus to +12V which prevented the strain gauge experiment from overheating. Finally, the buck regulator circuit was further refined and used on a Goddard Spaceflight Center's CubeSat on the Special Services Card (SSC) to provide constant current for deployment of the solar panels and magnetometer boom.

The primary objective of this effort is to develop a solid-state circuit in a small footprint that will efficiently convert a raw battery voltage to an adjustable constant voltage or constant current output. Additionally, the APSU will integrate a microcontroller to adjust output set points, turn services on and off, and monitor power draw of active loads for fault detection and isolation.

The APSU proposal addresses risk reduction in existing airborne power distribution systems commonly used on suborbital platforms. For example, Sounding Rocket PIs are currently responsible for providing their own experiment power conditioning. The APSU would enable consolidation of power distribution and generation to a single architecture with fault protection (i.e. overvoltage, overcurrent, etc.), allowing NASA to provide experiment power conditioning as a standard service to the suborbital science community.

In addition to the suborbital science community, the APSU core technology could be modified to meet CubeSat needs with appropriate parts selection for the mission environment, allowing it to be utilized by the SmallSat community to deploy solar panels via electric motors, actuate CubeSat deployables via burn wires, or provide power conditioning to multiple satellite experiments utilizing a common battery bus.

The innovative elements of the work proposed are: high efficiency power conversion (switching versus linear), small form-factor, inherent fault protection, and robust solid state circuitry.



APSU Block Diagram

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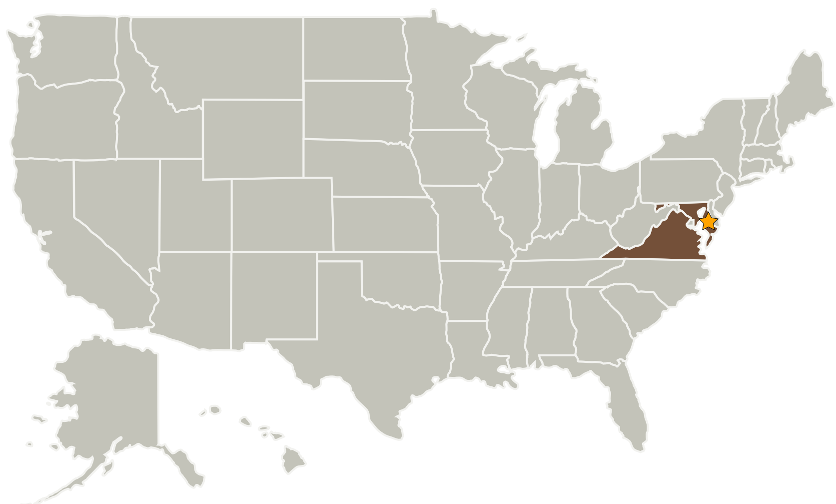
Anticipated Benefits

The return on investment to the Center is increased mission reliability with the ultimate goal of producing a versatile, common-use architecture with flight heritage. At least one unsuccessful sounding rocket mission within the last 5 years was attributed to an experimenter-designed power system that failed in-flight. The APSU directly addresses this failure mode by providing a NASA-engineered and qualified power conditioning system as a standard service. Additional benefits include increased maximum output capability over the current state-of-the-art and adaptation in an Integration and Test environment (ex. Experimenter needs +5V instead of +3.3V).

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Wallops Flight Facility(WFF)	Lead Organization	NASA Facility	Wallops Island, Virginia

Primary U.S. Work Locations	
Maryland	Virginia

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Wallops Flight Facility (WFF)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Managers:

Daniel A Mullinix
Michael G Hitch

Principal Investigator:

Scott V Hesh

Co-Investigator:

Taylor A Green

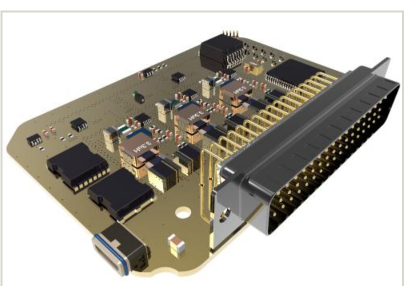
Project Transitions

October 2016: Project Start

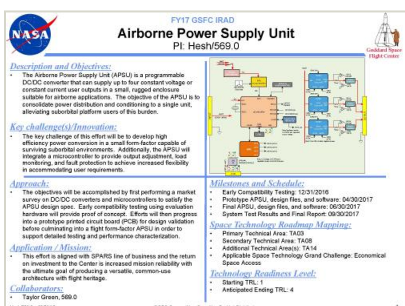
September 2017: Closed out

Closeout Summary: The purpose of the Goddard Space Flight Center’s Internal Research and Development (IRAD) program is to support new technology development and to address scientific challenges. Each year, Principal Investigators (PIs) submit IRAD proposals and compete for funding for their development projects. Goddard’s IRAD program supports eight Lines of Business: Astrophysics; Communications and Navigation; Cross-Cutting Technology and Capabilities; Earth Science; Heliophysics; Planetary Science; Science Small Satellites Technology; and Suborbital Platforms and Range Services.Task progress is evaluated twice a year at the Mid-term IRAD review and the end of the year. When the funding period has ended, the PIs compete again for IRAD funding or seek new sources of development and research funding or agree to external partnerships and collaborations. In some cases, when the development work has reached the appropriate Technology Readiness Level (TRL) level, the product is integrated into an actual NASA mission or used to support other government agencies. The technology may also be licensed out to the industry.The completion of a project does not necessarily indicate that the development work has stopped. The work could potentially continue in the future as a follow-on IRAD; or used in collaboration or partnership with Academia, Industry and other Government Agencies.If you are interested in partnering with NASA, see the TechPort Partnerships documentation available on the TechPort Help tab. http://techport.nasa.gov/help

Images



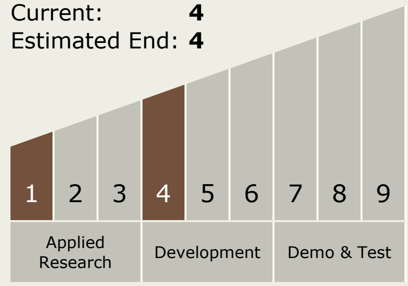
APSU Concept
Early concept of APSU featuring power converters in the middle surrounded be high current real estate. A microcontroller with USB-based communication and high-power dual input feeds for primary source selection are also included in the design.
(https://techport.nasa.gov/image/26019)



APSU Quad Chart
APSU Quad Chart
(https://techport.nasa.gov/image/24483)

Technology Maturity (TRL)

Start: **1**
Current: **4**
Estimated End: **4**



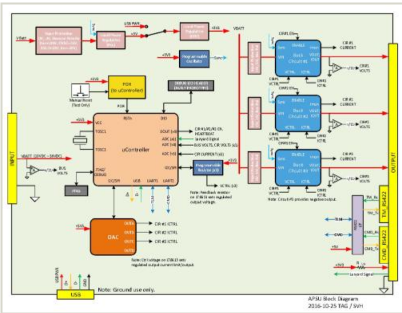
Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - └ TX03.3 Power Management and Distribution
    - └ TX03.3.3 Electrical Power Conversion and Regulation

Target Destinations

Foundational Knowledge, Earth



Block Diagram
APSU Block Diagram
(https://techport.nasa.gov/image/24482)

Project Website:

http://aetd.gsfc.nasa.gov/